USDA
NATURAL RESOURCES
CONSERVATION SERVICE

MARYLAND CONSERVATION
PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

CODE 441
(Reported by No. and Ac.)

DEFINITION

Microirrigation is an irrigation system for distribution of water directly to the plant root zone by means of surface or subsurface applicators.

PURPOSES

This practice may be applied for one or both of the following purposes:

1. To efficiently and uniformly apply irrigation water and maintain soil moisture for optimum plant growth;

2. To apply chemicals.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable on sites where the soils and topography are suitable for irrigation and proposed plants, and where a microirrigation system has been determined to be the most desirable method of irrigation.

Microirrigation systems, including subsurface drip irrigation (SDI), consist of bubblers (generally <60 gal/hr), drip or trickle emitters and tapes (generally <2 gal/hr), or spray or spinners (generally <45 gal/hr).

Microirrigation is suited to orchard and row crops, windbreaks, greenhouse crops, containerized nursery plants, and residential and commercial landscape systems. It is also useful on steep slopes where other irrigation methods would cause excessive erosion, and on areas where other application devices would interfere with cultural operations.

CONSIDERATIONS

Consider installing a microirrigation system where natural precipitation and/or stored soil water is not sufficient for seed germination and/or plant growth and survival.

Quality of the water source is usually the most important consideration when determining whether a microirrigation system is feasible. Well and surface water often contain high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. It is important to test the proposed irrigation water source to determine its suitability for use in a microirrigation system.

Consider that microirrigation systems can have adverse effects on surface and subsurface water quality. Microirrigation can influence runoff and deep percolation by raising the soil moisture level and decreasing available soil water storage capacity, thus increasing the probability of runoff or percolation below the root zone from storm events. Surface water quality may be affected by the movement of sediment, soluble chemicals, and sediment-attached substances carried by runoff. Ground water quality may be affected by the movement of dissolved substances below the root zone.

Microirrigation may affect downstream flows or aquifers and the amount of water available for other water uses.

Consider that there may be potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

Weather conditions must be considered before applying chemicals. Chemigation should not be applied if rainfall is imminent. Chemigation may be required at the same time the crop receives irrigation, while at other times chemical applica-

tions may be required when the irrigation water is not needed by the crop. This will affect the economics of chemigation. Pest management and nutrient management planning should address the timing and rate of chemical applications, as appropriate.

Consider how the system should be laid out. Field shape and slope frequently dictate the most economical direction for laterals. Whenever possible, laterals should be laid downslope for slopes of less than 5 percent if lateral size reduction can be attained. For steeper terrain, lateral lines should be laid along the field contour and pressure compensating emitters should be specified or pressure control devices used along downslope laterals.

For containerized nursery operations, consider using a microirrigation system for large containers (7 gallons and larger) to minimize water loss between containers. Microirrigation can also used with smaller containers.

Consider installing cutoff valves in laterals or emitter tubing, or use emitters with shutoff valves under containerized nursery operations. Operations often have irrigation beds that may not have complete coverage with containers. Added shutoff valves will allow for added flexibility to irrigate partial zones.

CRITERIA

General Criteria Applicable to All Purposes

All planned work shall comply with all Federal, State, and local laws and regulations.

The irrigation water supply shall be properly tested to determine feasibility and treatment needed for use in microirrigation systems.

The system shall be designed to uniformly apply water and/or chemicals directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

All microirrigation systems shall be operated in accordance with an irrigation water management (IWM) plan. IWM plans shall be in accordance with NRCS conservation practice standard for Irrigation Water Management, Code 449.

Depth of Application - Net depth of application shall be sufficient to replace the water used by the plant during the plant peak use period or critical growth stage without depleting the soil moisture in the root zone of the plant below the management allowed depletion (MAD). Gross depth of application shall be determined by using field application efficiencies consistent with the conservation use of water resources. Applications shall include adequate water for leaching to maintain a steady-state salt balance. The net depth of application shall be expressed as inches per day per unit of design area.

$$F_n = 1.604 \frac{QNTE}{AF}$$

Where: F_n = net application depth, in/day/design area

Q = discharge rate, gal/hr/emitter

N = number of orifices or emitters

T = hours of operation per day, 22 hours maximum

E = field application efficiency, expressed as a decimal

A = ft^2 of field area served by N (number of emitters)

F = the design area as a percentage of the field area, expressed as a decimal

1.604 = units conversion constant

For containerized plants, the amount of irrigation water applied will depend upon container size, substrate type, species and time of year. Following irrigation, producers should observe the amount of water exiting containers to determine how to fine tune their application amounts. The volume of water passing through the container at each irrigation should not exceed 25 percent of the water applied to the substrate surface.

System Capacity - The microirrigation system shall apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The system design capacity shall be adequate to meet the intended water demands during the peak use period for all plants to be irrigated in the design area. Design capacity shall include an allowance for reasonable water losses (evaporation, runoff, and deep percolation) during application periods. The system shall have the capac-

ity to apply a specified amount of water to the design area within the net operation period.

The system shall have a minimum design capacity sufficient to deliver the peak daily irrigation water requirements in 90 percent of the time available, but not to exceed 22 hours of operation per day. The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Field application efficiency (E) for design purposes shall not exceed 90 percent.

For non-orchard crops, the design area may be less than 100 percent of the field area (A) but not less than the mature crop root zone area.

For orchard crops, it is desirable to wet the entire area under the canopy of the mature tree. P_w (percent plant wetted area) is not required on high water table soils when the water table is managed at a depth where capillary action will supply a portion of the entire daily consumptive use rate. National Engineering Handbook (NEH), Part 623, Irrigation, Chapter 7, shall be used to calculate P_w and determine desirable P_w on other crops.

Emitter Discharge Rate - The design discharge rate of applicators shall be determined from manufacturer's data for the expected operating range. The discharge rate shall not create runoff within the immediate application area. For bubbler irrigation, a basin beneath the plant canopy is required for water control, with applications confined to the basin area.

The discharge rate of applicators (orifices, emitters, porous tubing, or perforated pipe) may be determined from the manufacturer's data relating to discharge and operating pressure.

Number and Spacing of Emitters - The number and spacing of emitters along the lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). NEH, Part 623, Chapter 7, shall be used to determine the P_w.

Applicators shall be located to provide an overlap of the wetting pattern within the root zone of the crop. Applicators are not required to provide an overlap of the wetting pattern when the crop is trees or shrubs.

Operating Pressure - The design operating pressure shall be in accordance with manufacturer recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter Manufacturing Variability - The manufacturer's coefficient of variation (C_v) shall be less than 0.07 for point source emitters and less than 0.20 for line source emitters.

Allowable Pressure Variations - The following criteria are applicable for manifold and lateral lines, and main and submain lines:

1. Manifold and lateral lines - Manifold and lateral lines, operating at the design pressure, shall be designed to provide discharge to any applicator in an irrigation subunit operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Pressure shall conform to manufacturer's recommendations.

2. Main and submain lines - Main and submain lines shall be designed to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit. Adequate pressure shall be provided to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.).

   Pipe sizes for mains and submains shall maintain flow velocities and emission uniformity (EU) within recommended limits as determined by procedures contained in National Engineering Handbook (NEH) Part 623, Chapter 7. Economic considerations shall include both installation and operating costs. Main and submain lines shall be designed and installed according to NRCS conservation practice standard Irrigation Water Conveyance, Pipelines, Code 430.

Filters - A filtration system shall be provided at the system inlet. Under clean conditions, filters shall be designed for a head loss of 5 psi or less. Manufacturer's recommendations and data shall be used to design sand separators.

The filter element, strainer, or filtration media must be sized to prevent the passage of solids in sizes or quantities which would obstruct the emitter openings. Recommendations of the emitter

manufacturer shall be used in selecting the filtration system. However, filtration systems shall be designed to remove solids equal to or larger than one-fourth the diameter of the emitter opening or the emitter manufacturer's recommendations, whichever is more stringent.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10 percent of the system operation time. Within this 10 percent time period, the pressure loss across the filter must remain within the manufacturer's specification and shall not cause unacceptable EU. Filter/strainer systems designed for continuous flushing should have backwash rates not exceeding 1.0 percent of the system flow rate. These systems must not exceed the manufacturer's specified operational head loss across the filter/strainer.

Pressure Regulators - Pressure regulators shall be used where topography and the type of applicator dictate their use. Pressure regulators shall not be planned to compensate for improperly designed pipelines.

Chemical Water Treatment - Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

System Flushing - Appropriate fittings shall be installed above ground at the ends of all mains, submains, manifolds, and laterals to facilitate flushing. A minimum flow velocity of 2 ft/sec is considered adequate for flushing.

Subsurface Irrigation - Tubing depth and spacing are soil and crop dependent. Emitting lines shall be placed at a depth considering the need for irrigation for germination and initial development, while considering leaching potential from the soil profile. Maximum lateral line distance from the crop row shall be less than or equal to 24 inches for annual crops and less than or equal to 48 inches for perennial crops. EU shall be designed for a minimum of 85 percent.

Water flow in the dripline shall be level to 2 percent downgrade with a maximum length of 660 feet. If these conditions are not met, the design shall be supported by engineering (hydraulic) documentation that shows EU of 85 percent or greater.

Additional Criteria for Chemigation

System EU shall not be less than 90 percent where fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit and placed in accordance with manufacturer's recommendation and include integrated back flow prevention protection.

Chemigation shall be accomplished in the minimum length of time needed to deliver the chemicals and flush the pipelines. Application amounts shall be limited to the minimum amount necessary, as recommended by the chemical label.

Care shall be taken so the injected materials do not adversely react with other chemicals in the irrigation water to cause precipitation and plugging.

The pest and/or nutrient management plan, as applicable, shall be followed concerning the timing and rate of application.

SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Considerations, Criteria, and Operation and Maintenance described in this standard. Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

An operation and maintenance (O&M) plan shall be prepared for use by the owner or others responsible for operating the system. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and prompt repair or replacement of damaged components. Frequent maintenance is essential to keep emitters functioning at design flow. Typical maintenance items include:

1. Clean or backflush filters when needed;

2. Flush lateral lines regularly;

3. Check applicator discharge often, replace applicators as necessary;

4. Check operating pressures often; a pressure drop (or rise) may indicate problems;

5. Check pressure gauges to ensure proper operation, repair/replace damaged gauges;

6. Inject chemicals as required to prevent precipitate buildup and algae growth;

7. Check chemical injection equipment regularly to ensure it is operating properly;

8. Check and assure proper operation of backflow protection devices;

9. Perform irrigation uniformity tests at least once a year.

All operations shall be performed in a safe manner and according to all applicable safety regulations.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

Planning Information, Field Data, and Survey Notes

1. Location and extent of the microirrigation system. Also note the location and extent of the practice on the conservation map;

2. Description of the objectives of the practice, including the desired functions that the microirrigation system is expected to provide;

3. Soils investigation logs and notes, as appropriate for site conditions and the proposed design;

4. Topographic survey of the site, as appropriate for site conditions and the proposed design.

Design Data

1. Location map with the site identified;

2. Soil survey map with the site identified;

3. Calculations that establish the design consumptive use of the crop, the depth of application, the emitter discharge rate, number and spacing of emitters, and system capacity;

4. A plan view showing the layout of the microirrigation system detailing the spacing of laterals and of emitters;

5. Pump and water supply requirements;

6. Filter requirements;

7. Grading plan for the site, where appropriate.

Construction Check Data/As Built Plans

1. Documentation of site visits on CPA-6 assistance notes. Include dates of site visits, name or initials of the person who made the visit, specifics as to what was inspected, all alternatives discussed, decisions made, and by whom;

2. Check notes recorded during and after completion of construction showing the as built elevations (if changed) and the layout of the microirrigation system;

3. Indicate the construction's conformance to the design on the plan;

4. Sign and date check notes and plans by a person with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

REFERENCES

1. University of Delaware, Cooperative Extension Service. *Delaware Irrigation Handbook.*

2. USDA, Natural Resources Conservation Service. *National Engineering Handbook, Part 652, Irrigation Guide*.